# REMOTE SENSING POTENTIALS TO ESTIMATE FOREST CARBON STOCKS IN INDONESIA & NEPAL IN THE CONTEXT OF REDD+

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# PRESENTATION OUTLINES

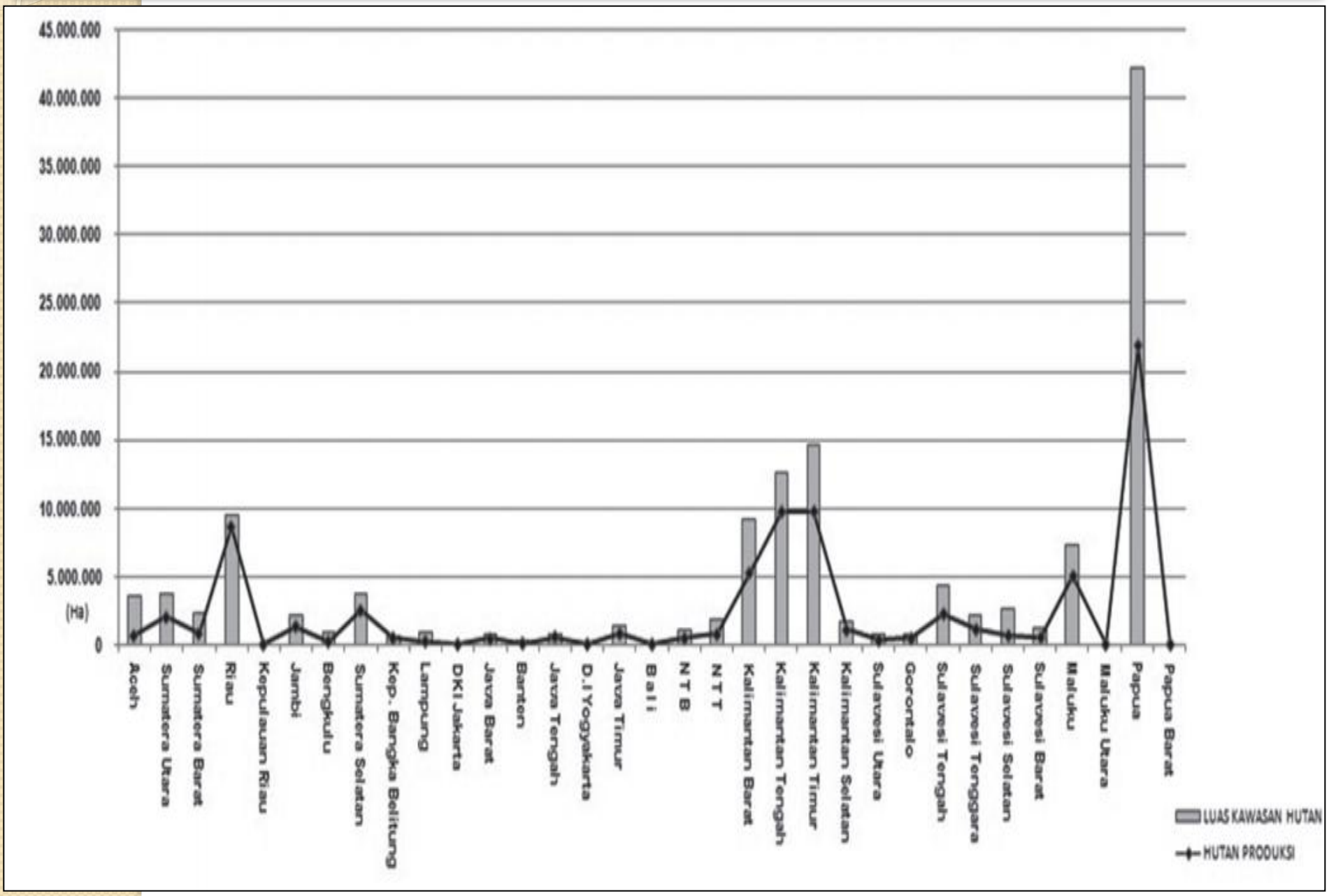
1. Overview
2. National Forest Inventories
3. Land cover, Remote Sensing & Carbon Trade
4. Conclusions
5. References

# I. OVERVIEW

# Overview of Indonesia Forest

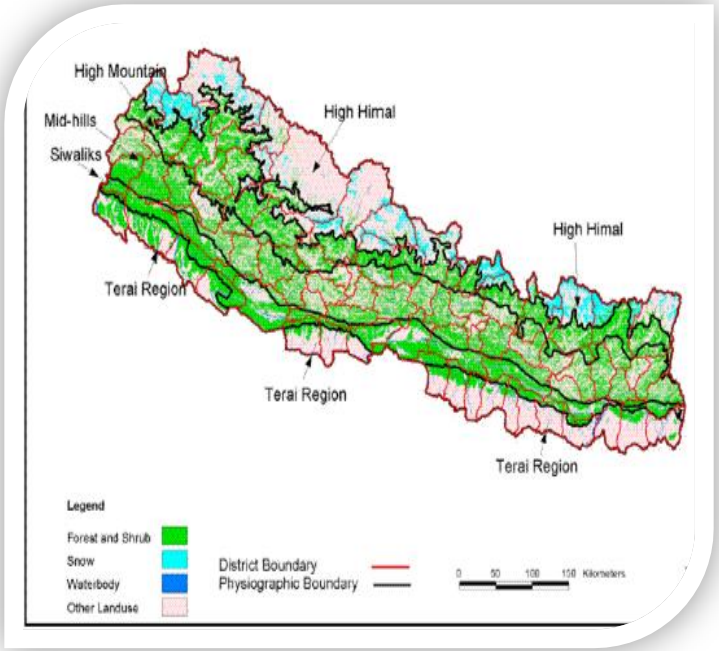
- Transition phases, mainly in Sumatra and other places: from natural forest, jungle rubber, forest plantation, rubber and oil palm plantation.
- From 120.3 million ha of forest state, almost half of it (46,5% atau 55,93 million hectares) are not intensively managed (MoF, 2011)
- 26 % emission reduction target from the 'Business as Usual' development scenario by 2020

# Comparison of the Forest Area and Production Forest for each province in Indonesia (*MOF, 2011*)



# NEPAL

- 0.03% of world area, landlocked
- 83% hills and mountains
- 39.6% forest area
- Annual deforestation rate = 1.7%
- Steep terrain
- More labour efforts and costs



# NEPAL'S INVOLVEMENT

- Insignificant GHG emission, High risk
- D & D : major sources of emission in developing countries (77% for Nepal)
- 8th worst deforestation (2000-2005)
- FCPF & REDD+SES member
- Latest NFI- 1991, Lack in carbon data
- Per capita $CO_2$ emissions: metric tons CO2; UN

| | |
|---|---|
| *1994* | *0.08* |
| *2001* | *0.138* |
| *2004* | *0.11* |

- Carbon emission rates are considered as the largest source of uncertainty in climate change scenarios.
- There is a difficulty in spatial explicitly estimating the carbon stocks and dynamic changes.
- Last 3 decades : significant advances in estimating forest biomass, including the application of different sensor data (Landsat, RADAR and LiDAR).
- For quantifying AGB and the associated changes, RS techniques have been found to be a potential tool in support of the Kyoto Protocol and its signatories (*Tomppo 2002*).

# Challenges in MRV in Indonesian Forests (Jaya, 2011)

- The diversity of forest ecosystem types which the results of variation in edaphic, climatic and geographical position.
- The diversity of socio-cultural of people and authority structure. It needs collaboration between stakeholders in order to establish successful implementation of REDD+, from the variation of authority structure in data collecting, validating and standard operation.

# MRV principles in REDD+ context (Masripatin, 2010)

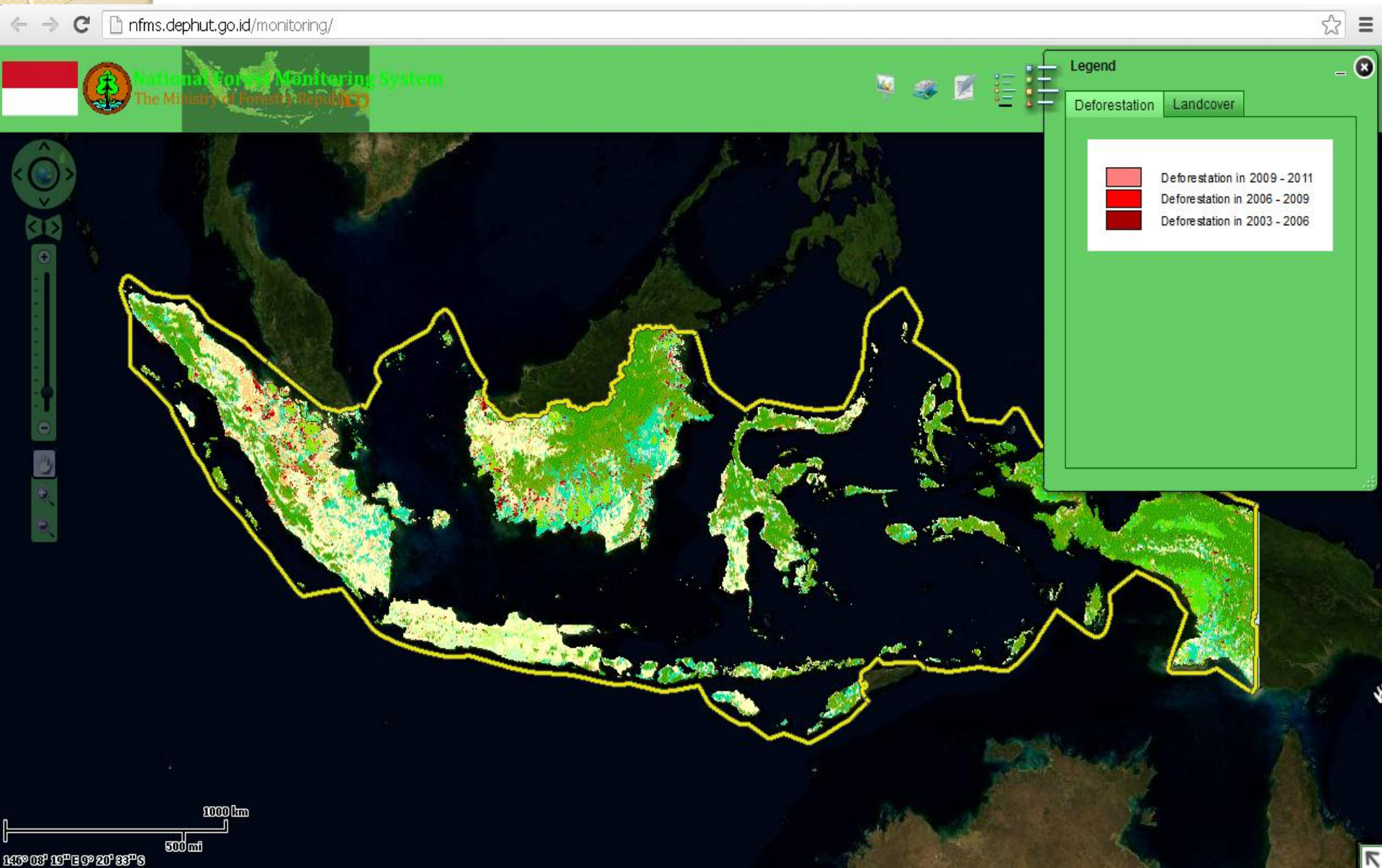
- Using the newest IPCC Guidelines (2006) : AFOLU (Agriculture, Forestry, Other Land Use)
- **Combination of remote-sensing & ground-based inventory,**
- Account for 5 carbon pools
- The result : transparent and open for review

# 2. National Forest Inventories

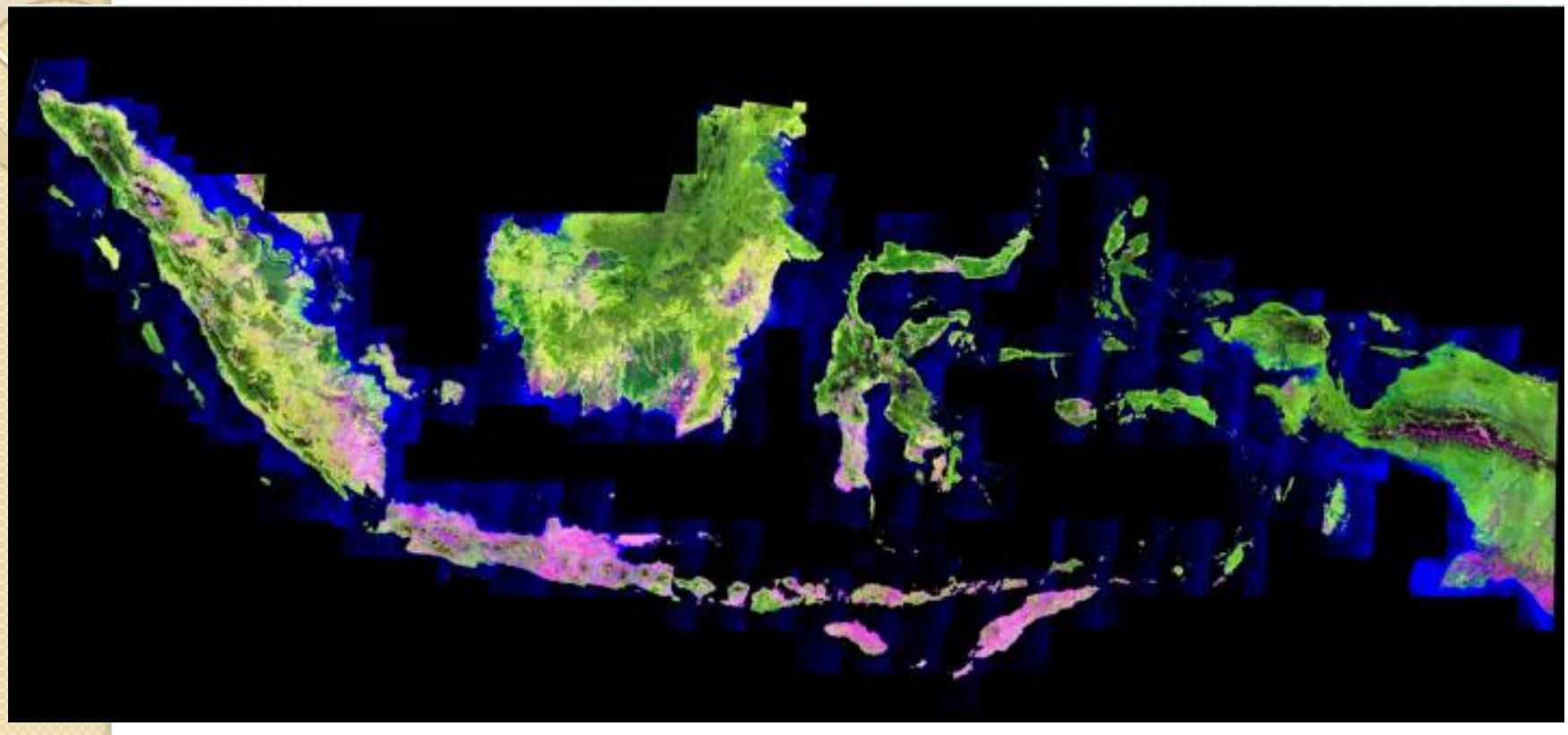
# INDONESIA & NFIs

- Landsat 5, Landsat 7 ETM+ (1990, 1996, 2000, 2003, 2006, 2009, 2011)
- annual forest resources monitoring, daily low resolution images data (MODIS) to produce monthly data
- Sample plots (Sugardiman, 2012):
  - 1990-1996 ( 2.735 cluster plots)
  - 1996-2000 ( 1.145 cluster plots)
  - 2000-2006 ( 485 cluster plots)
  - 2006-2014 (>3.000 cluster plots) to redesign NFI

# The display of National Forest Monitoring System from the website of Ministry of Forestry, Republic of Indonesia (*http://nfms.dephut.go.id/monitoring* accessed on15 November 2012)



# Land cover mapping : Landsat 7 ETM+ (217 scenes)

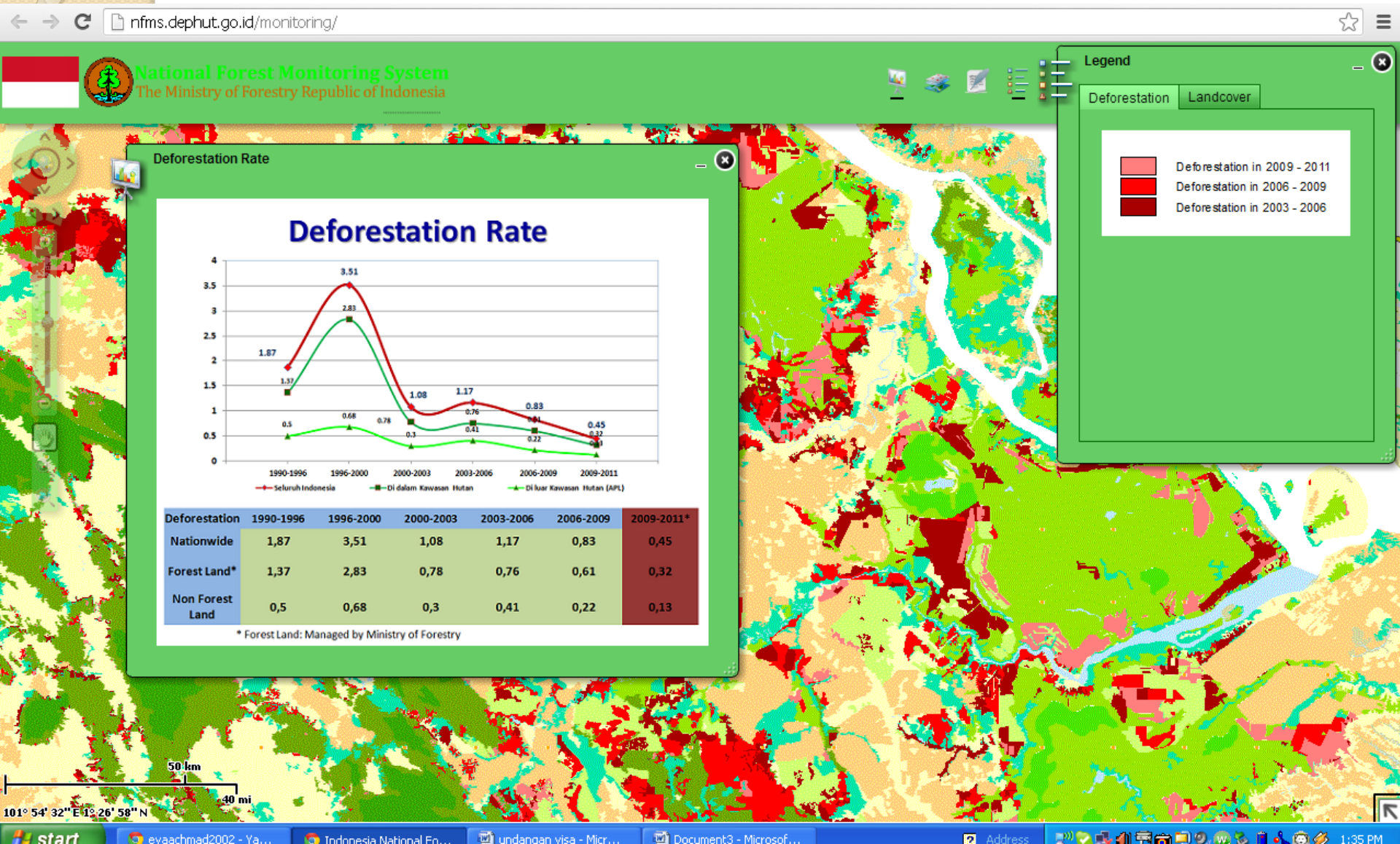


Source: Sugardiman, 2012

# NEPAL & NFIs

- Lot of inaccessible areas
- High correlations: spectral bands & veg. parameters
- VIs - useful estimates of carbon content
- LiDAR- direct biomass estimation- FRA
- ***FRSO (1963/64)*** **–** AP + Field inventory
- ***LRMP (1978/79)*** **–** AP + ground truth
- ***NFI (1994)*** **-** Landsat, AP, field measurements
- ***FRA Nepal (2010-2014 )*** **–** Ongoing (LiDAR)

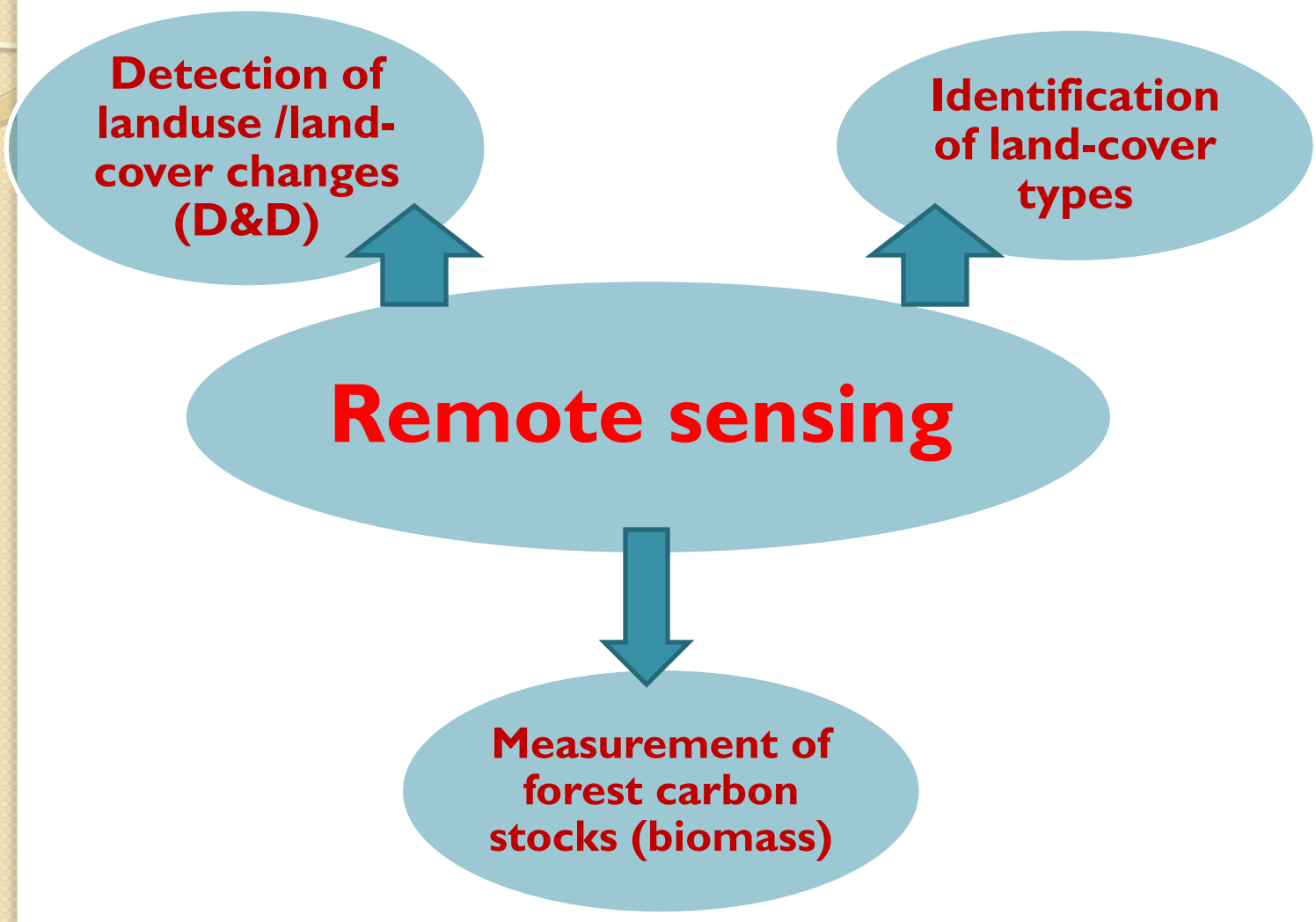
# Description of deforestation rate from National Forest Monitoring System from the website of Ministry of Forestry, Republic of Indonesia (*http://nfms.dephut.go.id/monitoring* accessed 15 November 2012)




| Deforestation | 1990-1996 | 1996-2000 | 2000-2003 | 2003-2006 | 2006-2009 | 2009-2011* |
|---|---|---|---|---|---|---|
| Nationwide | 1,87 | 3,51 | 1,08 | 1,17 | 0,83 | 0,45 |
| Forest Land* | 1,37 | 2,83 | 0,78 | 0,76 | 0,61 | 0,32 |
| Non Forest Land | 0,5 | 0,68 | 0,3 | 0,41 | 0,22 | 0,13 |

# 3. LAND COVER, REMOTE SENSING & CARBON TRADE

# MAJOR ISSUES IN REMOTE SENSING IN REDD+



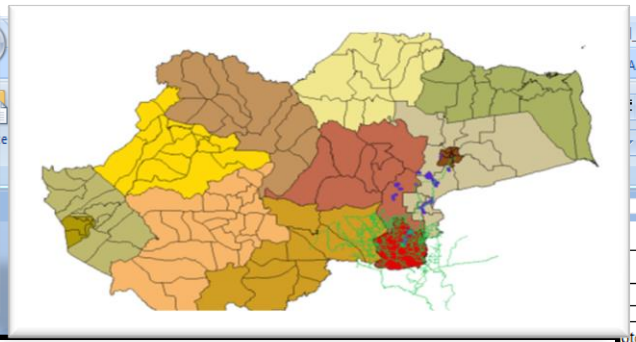
## *UN-REDD*

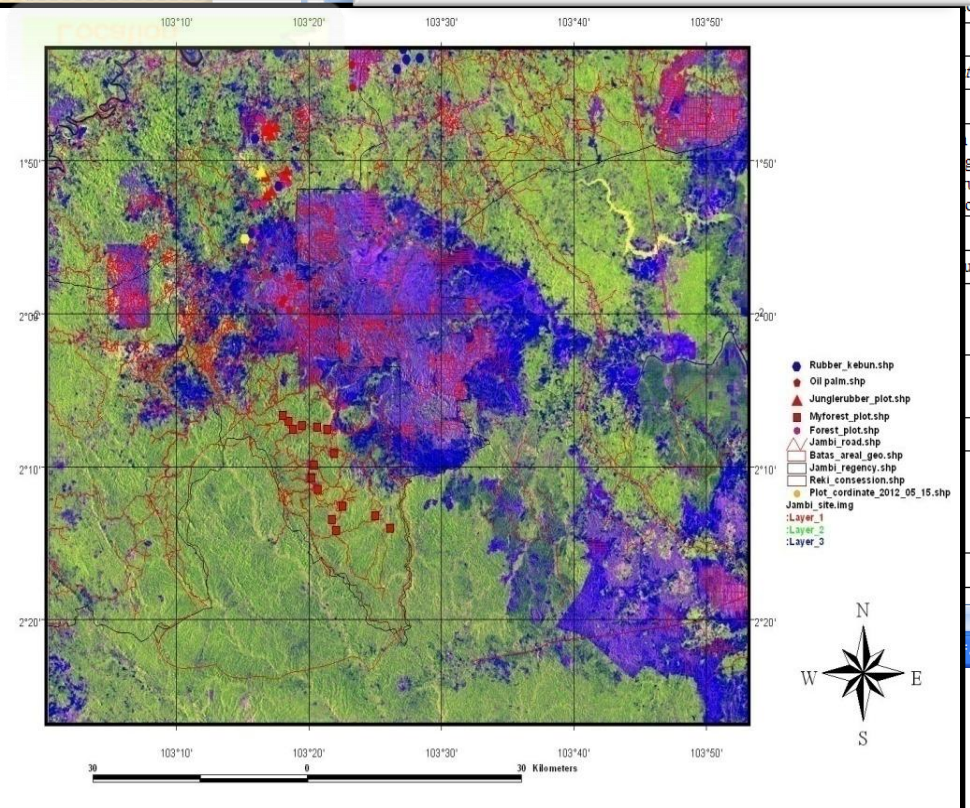
- Satellite RS important for REDD mechanism
- Very useful for MRV of REDD+

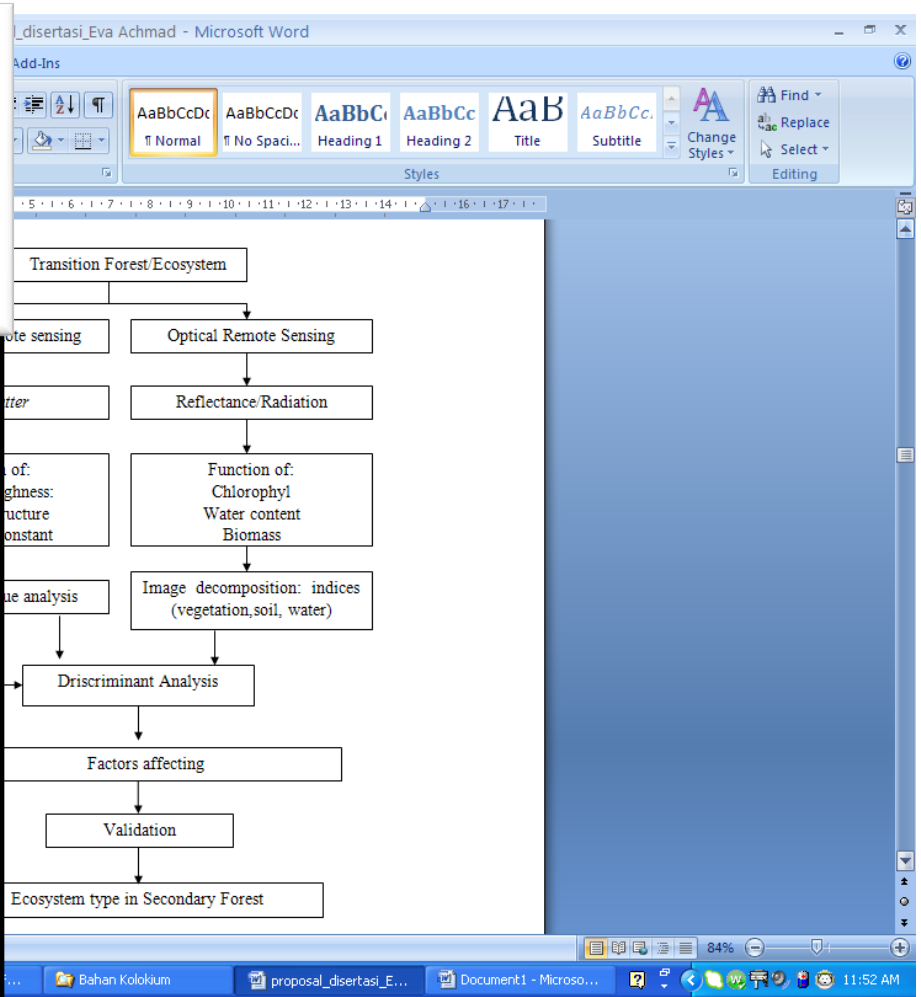
## *FOREST FUNCTIONS*

- Traditional - wood production
- Modern – social, environmental, economical and cultural aspects
- Much data needed
- Forest biomass measurement- Landsat, RADAR, LiDAR

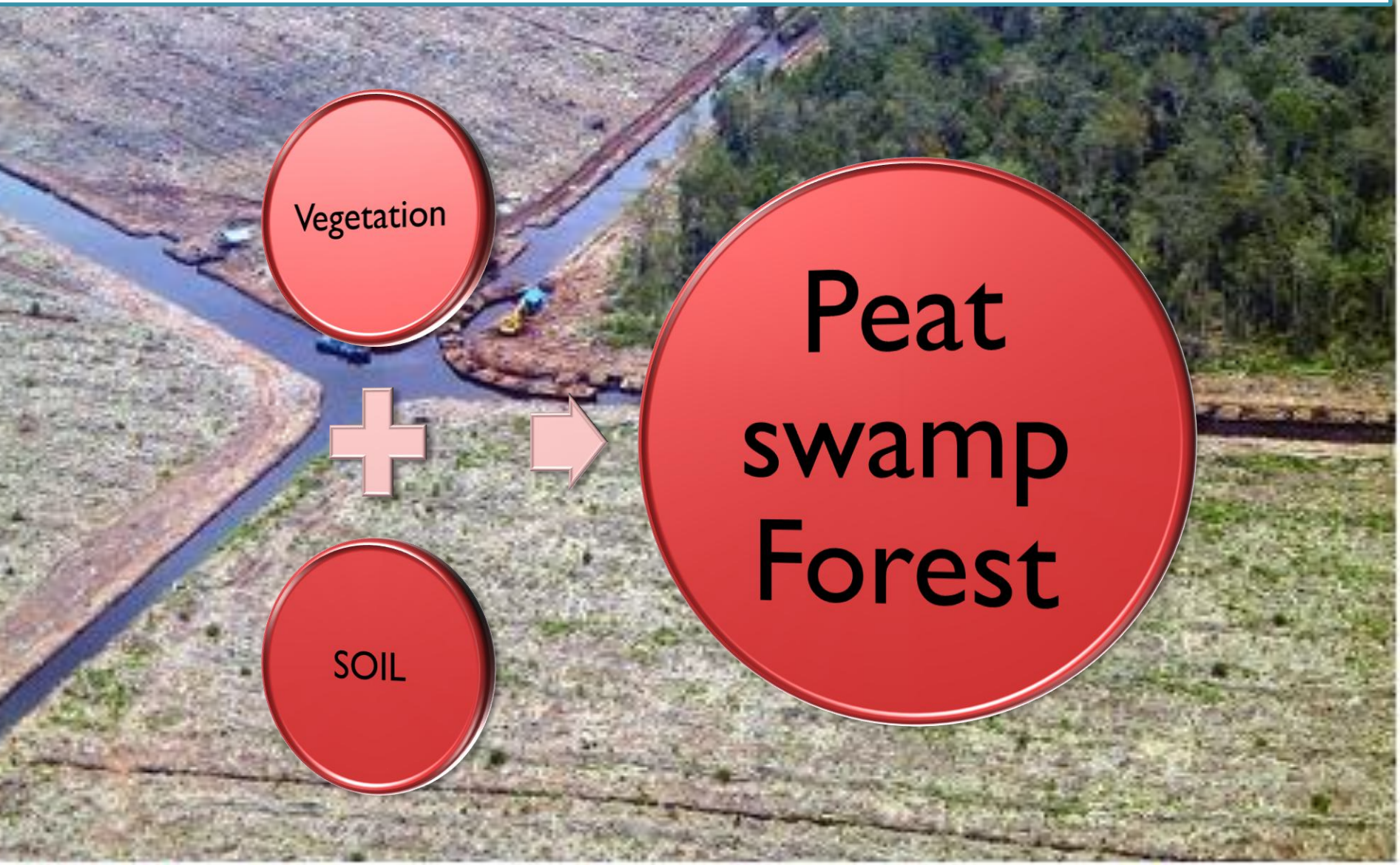
# IDENTIFICATION OF FOREST COVER WITH REMOTE SENSING



# CARBON TRADE



# WETLAND (PEATLAND) PROBLEMS TO MEASURE CARBON

- Variation in area and distribution of peat-land forests.
- No exact number about it.
- Najiyati *et al*., (2005) mentioned the range to be in between 13,5 to 26,5 m. ha.
- Needs remote sensing techniques/methods to give information about peat-land existence.

*Source: Landsat image downloaded from USGS website*

# LiDAR TECHNOLOGY

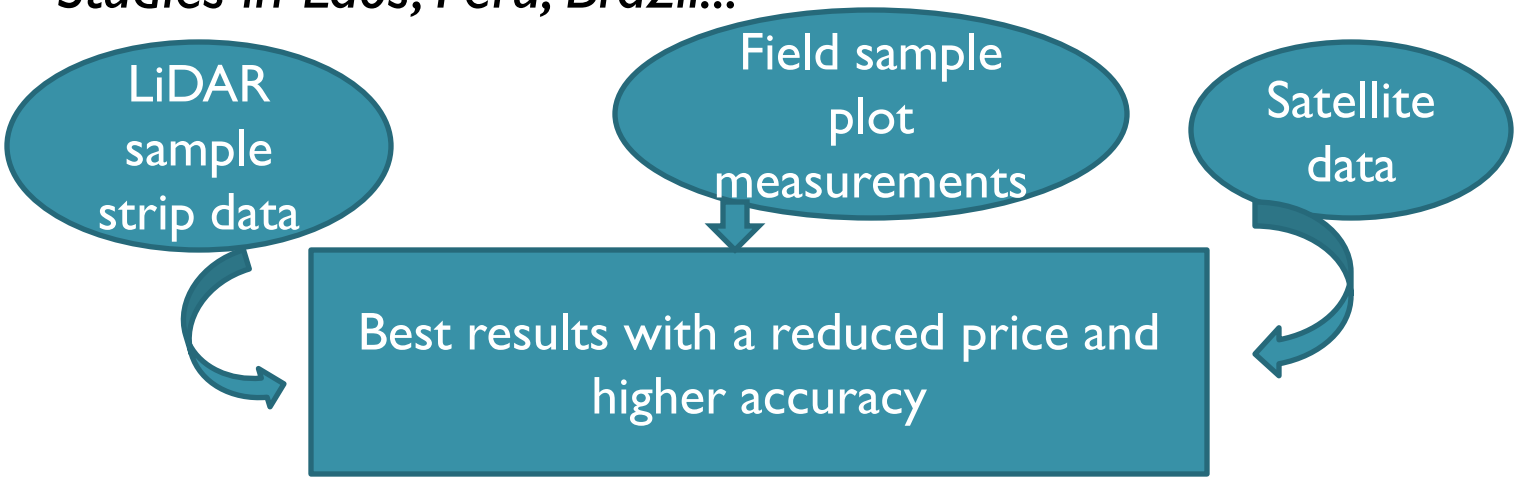
- Active RS technique, can be operated day/night
- Can be used
  - *In inaccessible places*
  - *Places where imagery is difficult*
  - *Places with persistent cloud cover*
- For accurate DEM generation and 3D mapping
- LiDAR pulses: reflected tree parts and also penetrate the canopy layer reaching the ground differentiating canopy layers

Acc. to a survey on a REDD+ pilot project in central Nepal by Bautista 2012,

*tree height measured from ground and that by LiDAR had no significant difference.*

# LiDAR, FRA & REDD

- ***Tomppo et al, 2008***
  - Recommend adopting an integrated approach based on **RS** data and field measurements for **FRA** and **REDD** monitoring proposes.
- ***Multi source sampling***
  - *Reduces the cost of monitoring*
  - *Can be used for deforestation and degradation monitoring in Nepal*
- *Studies in Laos, Peru, Brazil...*



# 4. CONCLUSIONS

- There is a need of reorganizing applications of remote sensing data in context of MRV for REDD+ and also the "site-specific" concerns for each types of forest ecosystems

- Development of methodologies in processing remotely sensed imageries (building algorithms and software)

- Capacity building to master and integrate remote sensing for REDD+

- Multi-source data can be used as a cost effective way of forest measurement and monitoring in developing countries

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